Hypothermia stage IV
Which patients to rewarm?

The HOPE score

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Hypothermia IV => prehospital

Hypothermia stage IV = Hypothermia and cardiac arrest

Potential for good outcome

“No one is dead until warm and dead”
Hypothermia IV => hospital

Does this patient may survive with proper treatment?

ExtraCorporeal Life Support (ECLS) rewarming
Hypothermia IV => hospital

ExtraCorporeal Life Support (ECLS) rewarming

Potassium

High

Low
Potassium triage: validated?

“Yeah, but good luck getting it peer-reviewed.”
A self-fulfilling prophecy is a prediction that directly or indirectly causes itself to become true.
What are the problems?

- Dichotomous approach based on sequential single variables (temperature, potassium)
- The evidence level is low
- The risk of bias is high
- Unique in emergency medicine to decide with one single biological parameter of life vs death
- A lot of potential prognostic factors or confounder in other ECLS studies are not included in the actual model
Key question

How can we better decide at hospital admission which hypothermic cardiac arrest patient would most benefit from ECLS rewarming?

=> Focus on the hospital decision

Main goals:
1) to collect retrospectively enough cases of CA patients rewarmed with ECLS
2) to build a score to predict survival
Clinical paper

Hypothermia outcome prediction after extracorporeal life support for hypothermic cardiac arrest patients: The HOPE score

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Methods

- Systematic literature review of retrospective cohort studies
- Hospital unpublished data
- Patients in hypothermic cardiac arrest with ECLS rewarming
- Consecutive cases of a time interval
- Primary outcome: survival to hospital discharge
- Main goal: to build a score predicting survival
Population (derivation cohort)

286 patients
Population (derivation cohort)

Table 1
Univariate associations between potential predictors and survival. All predictors apart the rewarming method were significantly associated with survival.

<table>
<thead>
<tr>
<th>Continuous potential predictors, median (IQR)</th>
<th>Survivors 106/286 = 37%</th>
<th>Non-survivors 180/286 = 63%</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>35 (16-55)</td>
<td>40 (18-56)</td>
<td>0.035</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>24 (22-27)</td>
<td>23 (21-25)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Potassium (mmol/L)</td>
<td>4.7 (3.6-6.6)</td>
<td>3.8 (3.1-4.65)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>CPR duration (min)</td>
<td>120 (85-169)</td>
<td>106 (64-165)</td>
<td>0.013</td>
</tr>
</tbody>
</table>

Categorical potential predictors (%)
- Gender
  - Female
  - Male
- Mechanism
  - Exposure
  - Immersion
  - Submersion
  - Avalanche
  - Cardiac rhythm
  - Asystole
  - Ventricular fibrillation
  - FEA
  - CA Circumstance
  - Witnessed CA
  - Unwitnessed CA
- Type of ECLS
  - CFB
  - ECMO

There were 9 missing values (3 for the survivors, 6 for the dead) for the potassium and 16 for CPR duration (5 for the survivors, 11 for the dead). CA denotes Cardiac Arrest, CFB Cardiopulmonary Bypass, CPR Cardiopulmonary Resuscitation, ECCLS Extracorporeal Life Support ECMO Extracorporeal Membrane Oxygenation, FEA Pulseless Electrical Activity.

Mechanism

- Exposure
- Immersion
- Submersion
- Avalanche

51% asphyxia

- 37% survivors to hospital discharge (106/286)
- 84% survivors with good neurological outcome
Multivariable analysis

- Age
- Gender
- Mechanism
- Potassium
- Temperature
- Witnessed cardiac arrest
- Initial cardiac rhythm
- Low flow
- Type of ECLS

Score HOPE =

\[
\text{Score } \text{HOPE} = 2.44 - 0.0191 \times \text{age} - 1.55 \times \text{male} - 1.95 \times \text{asphyxia} - 2.07 \times \log_2(\text{potassium}) + 0.937 \times \text{temperature} - 0.0247 \times \text{temperature}^2 - 0.573 \times \log_2(\text{CPR duration})
\]
The HOPE score

Hypothermia Outcome Prediction after Extracorporeal Life Support for Hypothermic Cardiac Arrest Patients. The HOPE Score.

The HOPE score is the result of an international collaborative project initiated and led by the Emergency Department of the University Hospital of Lausanne, Switzerland. The HOPE score provides a prediction of the...
Survival probabilities

**Specificity**

51%

Specificity = probability that HOPE < 10% among the non-survivors

**Sensitivity**

100%

Sensitivity = probability that HOPE ≥ 10% among the survivors
HOPE vs potassium

Sensitivity

1 - Specificity

HOPE (AUC=0.89)
Potassium (AUC=0.77)
<table>
<thead>
<tr>
<th>Potassium</th>
<th>&gt;12</th>
<th>≤12</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>58</td>
<td>37</td>
</tr>
<tr>
<td>Rewarming not indicated</td>
<td>Futile rewarming (non-survivors)</td>
<td>Successful rewarming (survivors)</td>
</tr>
<tr>
<td>32</td>
<td>31</td>
<td>37</td>
</tr>
<tr>
<td>HOPE</td>
<td>&lt; 0.10</td>
<td>≥ 0.10</td>
</tr>
</tbody>
</table>
Internal validation #1

- Bootstrapping
- Year of data collection
- Origin of the data
- Hospital (lack of statistical evidence for a “center effect”)
Population (validation cohort)

- N=>100 cases
- Published or unpublished

- Results: validation is OK
- Publication end 2018
Multivariate outcome prediction

Six independent survival prediction parameters

Paradigm shift from dichotomous to multivariable outcome prediction

Tool for meaningful ECLS rewarming

Improved discrimination between good and poor outcome
**Conclusion**

- **HOPE score**
  - Performs better than potassium alone
  - Avoids futile rewarming attempts (overtriage)
  - Helps motivating ECLS teams for cases with potential for good outcome (undertriage)

- **HOPE score**
  - Internally validated
  - Externally validated
  - Beware of “extreme cases”